Westinghouse Electric Corporation, Baltimore, Md.

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NASA
Headquarters
Wash. 25, D. C.
Attn: Mr. Roland H. Chase, Technical Director
Code RET

Subject: MIROS Progress Letter No. 7
NASA Contract No. NASw-703

Dear Mr. Chase:

This letter is a statement of progress made on the MIROS project during the period from November 20, 1963 to December 20, 1963. This period constituted the second month of experimental work.

Work Accomplished

This month's efforts were significant in that the first modulation transfer scheme, the Mercury cell, has operated successfully.

An easily reproducible 50% absorption of the mercury 4047 Å line has been induced in the mercury absorption cell upon irradiation of the cell with 2537 Å radiation and a maximum absoprtion of 57% was obtained on one trial. It can be stated with confidence, therefore, that the mercury cell modulation transfer scheme is successfully realizing all expectations even at this elementary stage of the experiment.

Some preliminary attempts at determining the dependence of the modulation transfer scheme on such parameters as gas pressures, intensity of the incident beams, modulation rates, sample purities, etc. have been made and the following experimental results have been noted:

1. 4047 absorption depends on the partial pressure of the added N_2 gas. This

effect reaches a maximum at partial pressures of N_2 of from about 2mm to 4mm. (See figure I) The decrease in modulation on the high pressure side can be attributed in part to the localization of mercury 6^3P_0 metastables with higher N_2 pressure. This localization can actually be observed visually by removing the 2537 Å filter from the modulating source. One effect of removing this filter is to allow the 2967 Å Hg line to irradiate the filter. This line corresponds to a transition from the 6^3P_0 metastable level to the 6^3D_1 level. Because of the added nitrogen the 6^3P_0 level becomes highly populated so that the 2967 Å line is strongly absorbed causing in turn a higher than normal population of the 6^3D_1 state. From this state the atoms can decay to another level (6^1P_1) with the emission of a dirty yellow (5790 Å) line. It is this line which can be observed visually and which indicates that the cell is performing satisfactorily.

One can observe, when a pinch of nitrogen is admitted into the cell containing previously only mercury vapor at a pressure of about 10 microns, a yellow puff near the wall adjacent to the exciting source. This cloud is due to the process described above. This yellow cloud disappears rapidly and reappears after about 15 to thirty seconds depending on the nitrogen pressure. Finally the cloud settles down to an equilibrium state in which it is most dense near the wall adjacent to the exciting light and tapers off in density near the opposite side of the cell. If the nitrogen pressure is increased, the cloud becomes more localized at the face nearest the 2537 - 2967 Å source. In this way the diffusion of 6^3P_0 metastables as a function of N_2 pressure can be easily observed.

2. The dependence of the modulation transfer scheme on the two beam intensities has only been qualitatively noted to date. Estimates of the two beam powers certainly

lie in the milliwatt region since both sources are electrodeless discharge lamps. It was noted that marked absorption of the 4047 Å line occurred at practically all 2537 powers. A noteworthy example occurred during attempts to pulse the 2537 Å source with a ten kilocycle per second pulse rate and a 10% duty cycle. In this case the 2537 Å lamp barely glowed at all. However an estimated induced absorption under these conditions was above ten percent.

The above example also yielded a very rough estimate as to the modulation rates possible in this scheme. Modulation transfer capability certainly appears to be possible at one megacycle. The preliminary tests of modulation rates were made by attempting to pulse the exciting lamp. This method is quite inefficient however under the present arrangement since it is almost impossible to pulse a gas discharge lamp at a rate over one megacycle per second. In addition the associated electronic circuits will have to be refined before any reliable measurements can be made. Even so, the rise time of the pulses was observed to be of the order of one tenth microsecond, so it can be concluded that the Hg absorption cell is capable of transferring modulation at least at a rate of tens of megacycles.

One notable dependence of the system is its critical dependence on the purity of the nitrogen. The failure of initial attempts at cross modulation is attributed mainly to the critical dependence on this parameter. This suspicion is strengthened further on noting that the mercury cell will not operate satisfactorily until it has been thoroughly flushed with super dry nitrogen. This observation is reasonable since it is noted that hydrogen has the ability to quench excited mercury to the ground state about ten times faster than nitrogen can quench it to the metastable level. During the course of the experiment, more study of this will be made.

Modulation transfer according to this method is not dependent on polarization nor any other influences such as a magnetic or electric field, unless these fields are very intense. During the course of the experiment some attempts at modulation using magnetic fields (the Zeeman effect) will take place. Further discussion of this work will follow in later reports.

Meetings

A meeting between N.A.S.A. and Westinghouse took place on Thursday, December 12 in order to discuss progress on the MIROS contract. Attendees included Dr. H. Plotkin and Mr. Roland H. Chase of NASA and Mssrs. Kline, Spencer, Anderson, Goodell and Dr. Reinitz of Westinghouse.

During this meeting it was stated that the directorship of MIROS would be transferred from headquarters to Goddard under Dr. Plotkin. This transfer was not expected to change the course of the present contract significantly. The morning was then spent discussing the different MIROS schemes, principally the mercury cell scheme in detail, then Dr. Reinitz discussed at length the principle of modulation transfer using alkali halide crystals.

In the afternoon the experimental set ups were examined. An attempt at cross modulation using the mercury cell was made which did not succeed, probably because of impurities in the cell. Afterwards Dr. Reinitz displayed the equipment to be used in the alkali halide experiment including crystals colored here at Westinghouse Aerospace by a diffusion method.

Plans for the Next Period

Plans for the next period include intensive experimental laboratory measurements of the mercury cell modulation transfer scheme and it is expected that the set up for the alkali halide experiment will have been completed and that same first

results will be obtained. Finally, theoretical work will continue on the remaining MIROS schemes.

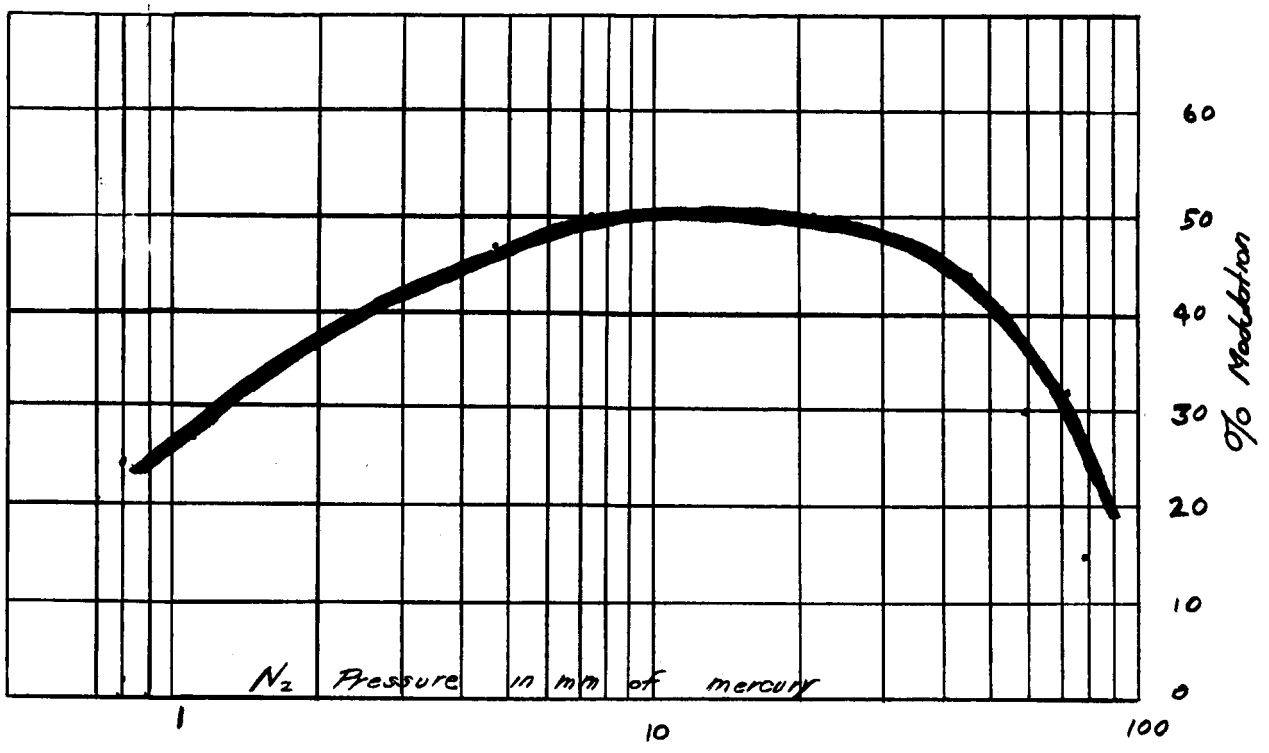

Fig. I Percent Modulation of the 4047 Å Mercury line as a function of N_2 pressure.